# LISTING OF ALL CLAIMS

SERIAL NO. 10/036,067

DOCKET: 10630/9

1. (Previously Amended) A plasma treatment apparatus, comprising:

at least first and second cathodes separated by a gap, said first cathode comprising a first exposed cathode surface and a first magnetic polarity, said second cathode comprising a second exposed cathode surface and a second magnetic polarity, and said first exposed cathode surface oriented non-parallel to said second exposed cathode surface;

a set of magnets operative to generate a magnetic field exiting from one of the cathodes and entering the other of the cathodes, thereby crossing the gap;

said magnetic field comprising a first magnetic field portion crossing the gap and passing through said first exposed cathode surface, said first magnetic field portion comprising magnetic field lines having a maximum field strength of at least 100 Gauss;

at least one anode structure positioned to create an electric field extending from the cathodes to the anode structure, at least a portion of said electric field crossing said magnetic field and forming a closed-loop electron containment region within said magnetic field, a sufficient voltage between the anode structure and the cathodes operative to form a plasma within the magnetic field when a gas is present near the containment region at a gas pressure between 0.1 and 100 mTorr; and

at least one substrate positioned to be treated by said plasma.

2. (Original) The apparatus of claim 1 wherein the substrate is positioned to be treated by the plasma with a treatment selected from the group consisting of: a chemical vapor deposition process, a surface modification process, an etching process, a sputter-coating process, and combinations thereof.

3. (Original) The apparatus of claim 1 wherein the magnetic field comprises a mirror-type magnetic field at least in a peripheral portion of the magnetic field.

4. (Original) The apparatus of claim 1 wherein the first exposed cathode surface faces the substrate.

5. (Original) The apparatus of claim 4 wherein the first exposed cathode surface extends over a length measured along the gap and a width measured transverse to the length, and wherein the width is at least 1 cm.

6. (Original) The apparatus of claim 1 wherein at least one of the cathodes comprises a non-planar cathode surface.

7. (Previously Amended) The apparatus of claim 6 wherein at least one of the cathodes comprises a facing cathode surface having a shape ~~shaped~~ selected from the group consisting of: a point, a bevel, a rounded surface, a stepped surface, a ridged surface, and combinations thereof.

8. (Original) The apparatus of claim 1 wherein the first cathode comprises a facing cathode surface oriented to face the second cathode, wherein the first exposed cathode surface has a length extending along the gap and width W1 measured transverse to the length, wherein the facing cathode surface has a width W2 measured transverse to the length, and wherein W1/W2 is no less than 0.2.

9. (Original) The apparatus of claim 8 wherein the length is greater than the width W2.

10. (Original) The apparatus of claim 8 wherein the width W1 is no less than 1 cm.

11. (Original) The apparatus of claim 1 wherein the cathodes comprise ends and a central portion, and wherein the cathodes are shaped such that the gap is wider at the ends than at the central portion.

12. (Original) The apparatus of claim 11 wherein the ends of the cathodes are beveled.

13. (Original) The apparatus of claim 1 wherein the magnetic field comprises a maximum strength magnetic field line, wherein the maximum strength magnetic field line has a maximum magnetic field strength B1 adjacent one of the cathodes and a minimum magnetic field strength B2 at a central portion of the gap, and wherein B1/B2 is greater than 2.

14. (Original) The apparatus of claim 13 wherein B1/B2 is greater than 4.

15. (Original) The apparatus of claim 1 wherein the electron containment region is centered in a plane that is oriented perpendicular (.+-.45.degree.) to a portion of the substrate adjacent to the gap.

16. (Previously Amended) A plasma treatment apparatus, comprising:

at least first and second cathodes separated by a gap, said first cathode comprising a first magnetic polarity, and said second cathode comprising a second magnetic polarity;

a set of magnets operative to generate a magnetic field exiting from one of the cathodes and entering the other of the cathodes, thereby crossing the gap;

at least one anode structure positioned to create an electric field extending from the cathodes to the anode structure, at least a portion of said electric field crossing said magnetic field and forming a closed-loop electron containment region within said magnetic field, a sufficient voltage between the anode structure and the cathodes

operative to form a plasma within the magnetic field when a gas is present near the containment region at a gas pressure between 0.1 and 100 mTorr; and at least one substrate positioned to be treated by said plasma;

wherein the magnetic field is asymmetrical with respect to a central axis of the gap extending between the cathodes, and wherein the electron containment region extends farther away from the central axis on one side of the gap than on the other side of the gap.

17. (Original) The apparatus of claim 16 wherein the substrate is positioned on said one side of the gap.

18. (Previously Amended) A plasma treatment apparatus, comprising:

at least first and second cathodes separated by a gap, said first cathode comprising a first magnetic polarity, and said second cathode comprising a second magnetic polarity;

a set of magnets operative to generate a magnetic field exiting from one of the cathodes and entering the other of the cathodes, thereby crossing the gap;

at least one anode structure positioned to create an electric field extending from the cathodes to the anode structure, at least a portion of said electric field crossing said magnetic field and forming a closed-loop electron containment region within said magnetic field, a sufficient voltage between the anode structure and the cathodes operative to form a plasma within the magnetic field when a gas is present near the containment region at a gas pressure between 0.1 and 100 mTorr;

at least one substrate positioned to be treated by said plasma; and

a set of ferromagnetic elements magnetically coupled to the set of magnets to provide a ferromagnetic return magnetic path, thereby enhancing the magnetic field across the gap.

19. (Original) The apparatus of claim 18 wherein the electron containment region comprises first and second portions situated on respective sides of the gap, and wherein the second portion is situated between the gap and at least one element selected from the group consisting of: the set of magnets and the set of ferromagnetic elements.

20. (Original) The apparatus of claim 18 wherein the set of magnets and the set of ferromagnetic elements are included in a magnetic circuit, and wherein the gap is the largest non-ferromagnetic opening in the magnetic circuit.

21. (Previously Amended) A plasma treatment apparatus, comprising:

at least first and second cathodes separated by a gap, said first cathode comprising a first magnetic polarity, and said second cathode comprising a second magnetic polarity;

a set of magnets operative to generate a magnetic field exiting from one of the cathodes and entering the other of the cathodes, thereby crossing the gap;

at least one anode structure positioned to create an electric field extending from the cathodes to the anode structure, at least a portion of said electric field crossing said magnetic field and forming a closed-loop electron containment region within said magnetic field, a sufficient voltage between the anode structure and the cathodes operative to form a plasma within the magnetic field when a gas is present near the containment region at a gas pressure between 0.1 and 100 mTorr;

at least one substrate positioned to be treated by said plasma; an enclosure extending from the cathodes around a portion of the electron containment region positioned away from the substrate; and

a source of process gas positioned within the enclosure.

22. (Original) The apparatus of claim 21 wherein a major portion of the process gas from the source passes through the plasma containment region in leaving the enclosure.

23. (Original) The apparatus of claim 21 wherein the source of process gas comprises a tube positioned within the enclosure, said tube comprising gas-release openings.

24. (Original) The apparatus of claim 21 wherein the source of process gas comprises an evaporation source.

25. (Original) The apparatus of claim 21 wherein the source of process gas comprises a sputter source.

26. (Original) The apparatus of claim 21 wherein the source is positioned between the enclosure and a portion of the electron containment region.

27. (Original) The apparatus of claims 1, 16, 18 or 21 wherein the cathodes comprise removable shells.

28. (Original) The apparatus of claims 1, 18 or 21 wherein the magnetic field is asymmetrical with respect to a central axis of the gap extending between the cathodes, and wherein the electron containment region extends farther from the central axis on a front side of the gap facing the substrate than on a back side of the gap facing away from the substrate.

29. (Original) The apparatus of claims 1, 16, 18 or 21 wherein the cathodes are asymmetrical with respect to a central axis of the gap.

30. (Original) The apparatus of claims 1, 16, 18 or 21 wherein the set of magnets comprises a permanent magnet.

31. (Original) The apparatus of claims 1, 16, 18 or 21 wherein the set of magnets comprises an electromagnet.

32. (Original) The apparatus of claims 1, 16, 18 or 21 wherein the gap is elongated along a length axis, and wherein each of the cathodes comprises a plurality of segments positioned adjacent to one another along the length axis.

33. (Original) The apparatus of claims 1 or 18 wherein the at least one substrate is positioned on both sides of the gap for treatment by the plasma.